REMARKS

Claims 1-15 and 17-20 remain in the application. Claims 1-3, 6-13, and 17-19 remain in original form, claims 4, 5, 14, 15, and 20 were previously presented, and claim 16 was canceled without prejudice.

It is respectfully submitted that applicants have used the terms "uncategorized" and "unclassified" as they are commonly defined, i.e., the terms mean not placed into a distinct class.

REJECTION OF CLAIMS 1, 2, 10-12, 15, AND 16 UNDER 35 U.S.C. § 102(e)

Claims 1, 2, 10-12, 15, and 16 were rejected under 35 U.S.C. § 102(e) as being anticipated by Ferrell et al. This rejection is respectfully traversed.

The Office action alleges that Ferrell et al. disclose in column 2, lines 55-59, column 4, lines 64-67, and column 5, lines 6-9, of U.S. Patent No. 6,751,343 (i.e., the '343 patent), a method for performing defect spatial signature (numerical descriptors or feature vectors) analysis of a semiconductor process that is described in column 2, lines 8-33 and lines 36-41 of the '343 patent. It is respectfully submitted that the Office action misconstrues the teachings of Ferrell et al. to arrive at an improper basis for rejecting applicants' claims 1, 2, 10-12, and 16. To better understand how the Office action misconstrues the teachings of Ferrell et al., applicants respectfully point out that Ferrell et al. teach in column 1, lines 32-51, that image knowledge structure and an access method for retrieving images are two significant problems in the design of large intelligent image database systems. Content-based image retrieval [CBIR] represents a promising and cutting-edge technology useful in addressing the problem of high-speed image storage and retrieval. Specifically, CBIR refers to techniques used to index and retrieve images from databases based on their pictorial content. Typically, pictorial content is defined by a set of features extracted from an image that describes the color, texture, and/or shape of the entire image or of specific objects. This feature description is used in CBIR to index a database through various means such as distance-based techniques, rule-based decision making, and fuzzy inferencing. Yet, to date, no significant work has been accomplished

to apply these technologies to the manufacturing environment. Notwithstanding, imagery collected from the manufacturing processes have unique characteristics that can be taken advantage of in developing a manufacturing-specific CBIR approach. ... Semiconductor manufacturing is representative of an industry that has a mature computer vision component for the inspection of product. Digital imagery for failure analysis is generated between process steps from optical microscopy and laser scattering systems and from confocal, SEM, atomic force microscope and focused ion beam imaging modalities. This data is maintained in a yield management database and used by fabrication engineers to diagnose and source manufacturing problems, verify human assertions regarding the state of the manufacturing process, and to train inexperienced personnel on the wide variety of failure mechanisms observed. In this passage from the '343 patent, Ferrell et al. teach that in the past semiconductor manufacturers have collected large amounts of data but have not used CBIR to analyze this data and correct manufacturing steps that introduce defects in their products. And if semiconductor manufacturers were to use CBIR, they would index and retrieve images based on their pictorial content.

Ferrell et al. further teach in column 2, lines 8-33, that the semiconductor industry currently has no direct means of searching the yield management database using image-based queries. The ability to query the fabrication process is based primarily on date, lot, and wafer identification number. Although this approach can be useful, it limits the user's ability to quickly locate historical information. For example, if SEM review has determined that a particular defect or pattern problem exists on a wafer, the yield engineer must query on dates, lots, and wafers to find similar historical instances. Although roughly 70% of all space occupied in the database consists of imagery, queries to locate imagery are manual, indirect, tedious, and inefficient. Therefore, this becomes an iterative and slow process that can prove unwieldy in the modern semiconductor environment where a single manufacturing campus having multiple fabrication facilities at one site can generate thousands of images daily. If a query method can be designed that allows the user to look for similar informational content, a faster and more focused result can be achieved. A process for locating similar imagery based on image content, for example the image structure rather than the lot number, wafer identification, and date, would result in a reduced time-to-source. Thus, it is respectfully submitted that contrary

to the allegations in the Office action Ferrell et al. do not teach defect spatial signature analysis of a semiconductor process. Rather, Ferrell et al. are teaching that semiconductor manufacturers have relied on using lot number, wafer identification, and date to search their databases and that this method is slow and cumbersome. Indeed, Ferrell et al. teach that because of the disadvantages of the techniques semiconductor manufacturers had been using, a method for manufacturing-specific CBIR that addresses defect analysis, product quality control, and process understanding in the manufacturing environment was needed.

To accomplish their goal, Ferrell et al. teach in column 2, line 36, and continuing to column 4, line 7, a method and apparatus for indexing and retrieving manufacturing-specific digital imagery based on image content by providing manufacturing-specific, context based image retrieval in an industrial environment. In response to an industrial event, Ferrell et al. claim their method can afford fast access to historical image-based records of similar industrial events so that a corrective action can be quickly taken. Thus Ferrell et al. provide a method and apparatus for employing an image based query-by-example method to locate and retrieve similar imagery from a database of digital imagery. The method of Ferrell et al. includes a method for indexing and retrieving manufacturing-specific digital images based on image content that includes three steps using at least three steps. First, at least one feature vector can be extracted from a manufacturing-specific digital image stored in an image database. In particular, each extracted feature vector corresponds to a particular characteristic of the manufacturing-specific digital image. ... Second, using an unsupervised clustering method, each extracted feature vector can be indexed in a hierarchical search tree. ... Finally, a second level data reduction based upon the prototype vector can be performed, the second level data reduction resulting in a subset of the feature vectors comparable to the prototype vectors, and further comparable to the query vector. Still, the retrieving step can further comprise the step of fetching from the image database a manufacturing-specific digital image defined by an intersection of the three independent feature vectors corresponding to the prototype vector.

It was further alleged in the Office action that the method of Ferrell et al. comprises creating a defect database of wafers having spatial signatures, for example, the

Image Database 5 of Ferrell et al. It is respectfully submitted that Ferrell et al. do not include, teach, or suggest a database of spatial signatures, but a database containing a product image that is categorized by different features or characteristics. Support for this belief can be found in FIG. 4 and column 6, lines 38-51, which teach that the characteristics forming each feature vector as extracted by the image feature extraction module 2 can be grouped into descriptive categories: color, texture, and shape. Each feature contributing to the vector description can be generated by masking the image 8 and plane with an appropriate mask and measuring the feature according to appropriate equations. As an example, the table shown in FIG. 4 lists features measured from manufacturing imagery for CBIR analysis to describe defect, background, and global characteristics. These features can be described in terms of the color, shape, and texture of the area of interest. Still, the architecture is flexible and new descriptive features under continued investigation can be easily added. Thus, the image database 5 is not a database of spatial signatures but a database having a collection of manufacturing-specific images and descriptive data corresponding to each stored image.

The Office action further alleges that the spatial signatures in the defect database are uncategorized data in that they can correspond to unclassified defects (Ferrell et al. column 13, lines 3-5). As discussed hereinbefore, Ferrell et al. do not include, teach, or suggest a defect database containing defect spatial signatures. What is more, the Office action misrepresents the teachings of Ferrell et al. by alleging that their database can correspond to unclassified defects. Ferrell et al. teach in column 13, lines 1-9, that it is an object of their inventive method to provide end-user support for human-level assertions for sourcing manufacturing problems. Specifically, the inventive method can assist with off-line review and analysis of unclassifiable defects, provide assisted defect library generation for supervised automatic defect classification systems, provide unsupervised classification of defects during early yield learning, and, assist in training yield management personnel. Here, Ferrell et al. do not teach a database in which the defect spatial signatures are uncategorized data. Rather, Ferrell et al. teach a method for allowing human operators to review the data off-line so that it can be classified and entered into their database. Thus, it is believed that in this passage Ferrell et al. teach

categorization of the data not at a computer level but at a human level, i.e., the human operator intervenes to determine a classification of the data.

The Office action further alleges that the spatial signatures in the defect database are uncategorized data in their arrangement in the HST is according to their relative similarity (Ferrell et al., column 9, lines 48-56) as opposed to some defect classification schema. Ferrell et al. teach in column 9, lines 48-56 that FIG. 6 shows a schematic representation of a hierarchically ordered set of feature vectors 106, v_i, i=1, 2, …9. In the illustrated hierarchy, the vectors forming vector pair (v_3, v_1) have the most similar features to one another. Similarly, the features represented by vector pair (v_2, v_5) also have the most similar features to one another. The next closest pair of vectors (L_1, v_7) maintain a lesser degree of similarity than vector pair (v_3, v_1), where L_1 102 is the prototype of (v_3, v_1) at level 1 defined by the vector average, $<v_3, v_1>$. Here, Ferrell et al. are teaching categorizing the feature vectors by their most similar features. Thus, Ferrell et al. are clearly categorizing the feature vectors. What is more, as discussed hereinbefore, Ferrell et al. are not categorizing spatial signatures, instead they are categorizing feature vectors.

Applicants, on the other hand, teach on page 3, lines 8-28, a method for electronically searching a database to determine if a spatial signature has occurred before and, if so, notifying an engineer. … In a beginning step identified by reference number 21, an electronic wafer map for a first wafer having a defect associated therewith is generated. In a next step (reference number 23), the electronic wafer map of the first wafer is partitioned into defect regions or areas by identifying local densities of defects, i.e., the defects are clustered using mathematical clustering techniques or using a stylus and a pad. Briefly referring to FIG. 4, a wafer map 16 of a defect spatial signature having a cluster boundary 17 is illustrated. The clustering is accomplished using a stylus and pad coupled to a computer system displaying an image of the defect spatial signature. By way of example, the defects are caused at a furnace operation in a semiconductor manufacturing process. The wafer map is stored in a relational database (reference number 25), such that the relationship of the defects to each other are stored in a row and column format. In other words, coordinates of the process signature for each defect are stored in the database thereby creating a relational database. For example, the

coordinates of the process signature of a first defect are stored in the relational database and the coordinates of the process signature of a second defect are stored in the relational database. The wafer map of the first wafer is reconstructed from the relational database (reference number 29) and the wafer maps of the two wafers are electronically analyzed to determine if the wafer map of the first wafer correlates to that of the second wafer within a predetermined confidence level (reference number 31). If a match within the predetermined confidence level occurs, then the computer reports that a match has been encountered.

Accordingly applicants' claim 1 calls for, among other things, creating a defect database of wafers having defect spatial signatures, wherein the defect spatial signatures in the defect database are uncategorized data and determining if the recent defect spatial signature corresponds to at least one of the defect spatial signatures of the defect database. Claim 10 calls for, among other things, generating a database of process anomalies, wherein the process anomalies are uncorrelated and determining if the at least one process anomaly corresponds to a process anomaly in the database of process anomalies. Claim 15 calls for, among other things, storing a plurality of defect maps in a storage device, wherein the defect maps are uncorrelated and uncharacterized and determining if the defect map of the recent anomalous event corresponds to one of the plurality of defect maps in the storage device. At least these elements of claims 1, 10, and 15 are not included in the relied on reference of Ferrell et al. Because all limitations of applicants' claims 1, 10, and 15 are not included in the relied on reference of Ferrell et al., it cannot anticipate applicants' claims 1, 10, and 15.

Further, it is respectfully submitted that for a reference to anticipate a claim, it must not only include all the limitations of the claim but they must be included as they are arranged in the claim. A reference that almost meets this standard cannot anticipate a claim. Here, the Office action clearly admits that Ferrell et al. teach an arrangement in column 9, lines 48-56, that is being categorized by their relative similarity. The Office action further states in paragraph 23 that Ferrell et al. do not expressly show or suggest that the defect database. Although this statement is unclear, it is believed the Office action is stating that Ferrell et al. do not expressly show or suggest that the database is a defect database. Rather, Ferrell et al. teach an image database or a hierarchical search

tree. It is believed a typographical error exists in paragraph 23 in that it refers to a search free instead of a search tree. Thus, the patent to Ferrell et al. is deficient as a valid reference under 35 U.S.C. § 102 at least because it teaches categorizing features and because it does not teach a database with uncategorized spatial signatures.

Claim 2 depends from claim 1 and is believed allowable over the relied on reference of Ferrell et al. for at least the same reasons as claim 1. Claim 2 further sets out that the defect database contains uncorrelated data. At least this limitation of claim 2 is not included in the relied on reference of Ferrell et al., further precluding anticipation of applicants' claim 2.

Claims 11 and 12 depend from claim 10 and are believed allowable over the relied on reference of Ferrell et al. for at least the same reasons as claim 10. Claim 12 further sets out that the anomalies are uncategorized. At least this limitation of claim 12 is not included in the relied on reference of Ferrell et al., further precluding anticipation of applicants' claim 12.

Although claim 16 was rejected in the final rejection, it was canceled without prejudice in an amendment mailed to the United States Patent and Trademark Office on November 19, 2005. Accordingly, the rejection of claim 16 is moot.

REJECTION OF CLAIMS 3-5, 8, 13, 14, AND 18-20 UNDER 35 U.S.C. § 103(a)

Claims 3-5, 8, 13, 14, and 18-20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Farrell et al., in view of La et al. (U.S. Patent No. 5,761,064). This rejection is respectfully traversed.

As discussed hereinbefore, Ferrell et al. do not adequately satisfy the limitations of claim 1. Thus, the combination La et al. and Ferrell et al. is deficient in making obvious applicants' claims 3-5, 8, 13, 14, and 18-20. What is more, La et al. teach in column 3, lines 51-62, that the central database system is made up of a relational database installed on a server with memory to store the wafer defect data. The relational database organizes the wafer defect data in tables where it is tagged according to preselected criteria. The preselected criteria includes process technology, layer, lot, wafer, device, process equipment identification, and scan tool identification. The central database

system can access databases containing electrical test results and the in-line process monitor and equipment monitor information which is correlated to the pertinent wafer defect data. This correlated data is available for review at the user interface workstations. Thus, it is respectfully submitted that neither Ferrell et al. nor La et al., either alone or in combination, teach or suggest a database having uncharacterized, uncategorized, or uncorrelated data. Accordingly, the relied on references are deficient in making obvious applicants' claims 1, 10, or 15.

Claims 3-5 and 8 depend either directly or indirectly from claim 1 and are believed allowable over the relied on references, either singly or in combination, for at least the same reasons as claim 1. It is respectfully submitted that La et al. teach in column 7, lines 2-12, that the defect wafer map shows each individual die and a dot on each die in which there is a defect. The user can select any defect on any die for further examination by double-clicking on that defect. For example, defect map 140 shows a representative defect 144 which has been double-clicked (indicated by arrows 146) for further examination. The next chart generated is a defect optical image chart 148 of the defect in the selected die. The next chart generated is a scanning electron microscope (SEM) image 150. The user can then select a spectral analysis chart 152 of the wafer selected. It is respectfully submitted that La et al. do not teach or suggest storing coordinates of a process signature, but coordinates of individual defects. Claim 4, on the other hand, further sets out storing coordinates of a process signature of a first defect and storing coordinates of a process signature of a second defect from each wafer, wherein the spatial orientation of the coordinates of the process signatures of the first and second defects are in relation to each other. At least this limitation of claim 4 is not taught or suggested by the relied on references of Ferrell et al. or La et al., taken alone or in combination, further precluding obviousness of claim 4.

Claims 13 and 14 depend either directly or indirectly from claim 10 and are believed allowable over the relied on references, taken alone or together, for at least the same reasons as claim 10.

Claims 18-20 depend either directly or indirectly from claim 15 and are believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 15. Claim 19 further sets out storing coordinates of process

signature of a first defect and storing coordinates of a process signature of a second defect, wherein the coordinates of the process signatures of the first and second defects are in relation to each other. At least this limitation of claim 19 is not taught or suggested by the relied on references of Ferrell et al. or La et al., taken alone or in combination, further precluding obviousness of claim 19.

REJECTION OF CLAIM 6 UNDER 35 U.S.C. § 103(a)

Claim 6 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of Jain et al. (U.S. Patent No. 5,893,095). This rejection is respectfully traversed.

As discussed hereinbefore, Ferrell et al. do not adequately satisfy the limitations of claim 1. Thus, the combination Jain et al. and Ferrell et al. is deficient in making obvious applicants' claim 6.

Claim 6 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

REJECTION OF CLAIMS 7, 11, AND 17 UNDER 35 U.S.C. § 103(a)

Claims 7, 11, and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of Tobin et al. (U.S. Patent No. 6,535,776). This rejection is respectfully traversed.

As discussed hereinbefore, Ferrell et al. do not adequately satisfy the limitations of claim 1. Thus, the combination Tobin et al. and Ferrell et al. are deficient in making obvious applicants' claims 7, 11, and 17.

Claim 7 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

Claim 11 depends from claim 10 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 10.

Claim 17 depends from claim 15 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 15.

REJECTION OF CLAIM 9 UNDER 35 U.S.C. § 103(a)

Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ferrell et al. in view of the applicants' admitted prior art, as disclosed in the Applicants' Background of the Invention. This rejection is respectfully traversed.

As discussed hereinbefore, Ferrell et al. do not adequately satisfy the limitations of claim 1. Thus, the combination applicants' Background of the Invention and Ferrell et al. is deficient in making obvious applicants' claim 9.

Claim 9 depends from claim 1 and is believed allowable over the relied on references, either alone or in combination, for at least the same reasons as claim 1.

CONCLUSION

No new matter is introduced by the amendments herein. Based on the foregoing, applicants believe that all claims under consideration are in condition for allowance. Reconsideration of this application is respectfully requested.

Respectfully submitted,

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